



COMMERCIAL GROWING OF **ASPARAGUS**

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Cover Illustration.—Asparagus spear being cut for market.

WARNING

Recommendations for use of pesticides are reviewed regularly. The registrations on all suggested uses of pesticides in this publication were in effect at press time. Check with your county Agricultural Agent or State Agricultural Experiment Station to determine if these recommendations are still current.

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Commercial Growing of Asparagus

Prepared by
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Asparagus is a valuable early vegetable and an important perennial crop. It is healthful and palatable as a fresh vegetable as well as a canned or frozen product.

California leads all other States in asparagus production, followed by New Jersey and Washington. Illinois, Massachusetts, Michigan, Oregon, and Maryland produce significant but much smaller quantities for fresh consumption. Illinois, Michigan, Maryland, Delaware, and Oregon grow progressively smaller tonnages for canning and for freezing.

The total acreage of commercial asparagus in the United States—approximately 150,000 acres—has changed little in the last decade. Average yields are 2,200 to 2,600 pounds per acre.

Far more asparagus is grown for processing than for sale as a fresh product. This gap is expected to become even wider. Increasing amounts are grown for canning.

CLIMATIC AND SOIL REQUIREMENTS

Asparagus grows wild in many places where the seed has been scattered by wind, water, birds, and other carriers. Although the plant is grown in home gardens in nearly all sections of the country, conditions for commercial production are limited. Asparagus is a native of temperate regions and cultivation is most successful where low temperatures or drought stops growth of the plant and gives it a rest period.

Commercial asparagus culture should not be undertaken in areas where the plant continues to grow throughout the year. If the plant does not have a rest period, the shoots may become less vigorous and more spindly each year.

Yields in Southern States are often only one-third to one-half as great as yields in Northern States. Nutrition, cultural practices, and other factors may contribute to these differences; but it is believed that the lack of a winter rest period in the South is mainly responsible. In some sections that have mild winter temperatures and

¹The help of J. Howard Ellison in preparing this publication is acknowledged. He is a research specialist in vegetable crops at Rutgers University, New Brunswick, N.J.

low rainfall the required rest period can be induced by drought. In the Imperial Valley of California, for example, asparagus is given its rest period by withholding irrigation water.

Asparagus can be grown on many kinds of soil, but good drainage is essential. The asparagus plant has an extensive root system and for maximum development must have an open well-drained soil. The best types of soil for permanent plantings are deep, loose, and light, such as mucks and light sandy loams. Since early-spring growth depends on the reserve food in the fleshy roots, the soil should allow full development of the storage roots. These roots may reach a length of more than 10 feet. Where early growth is important, a soil that warms up readily in the spring is essential.

Very light sandy or gravelly soils having a porous subsoil should be avoided. The moisture-holding capacity of such soils is too low for profitable asparagus production. Soils having a gravelly or hardpan subsoil are also undesirable. Many of the commercial asparagus soils of the South have a light sandy topsoil underlain by clay. Heavy soils are not the best, but they may be satisfactory for asparagus if they are not so heavy that they bake. Heavy soils are more difficult to work, and they warm up slowly.

Asparagus is found growing naturally on the banks of streams and near salt marshes, where the salt content of the soil is high and the reaction somewhat alkaline. It

does well in moist places, if the water table does not come within 4 feet of the surface.

Asparagus will thrive in soils having a salt content too high for many other crop plants, but it will not tolerate extreme acidity. Soils ranging from slightly acid to slightly alkaline are best for asparagus. Land known to be very acid should have an application of lime to make the reaction nearly neutral before planting asparagus.

Asparagus has a broad tolerance to various salts. This makes it possible to grow asparagus on land that is too alkaline for other crops. However, the yields are likely to be lower and the life of the planting shorter on such land than where soils are nearly neutral in reaction.

FERTILIZING BEFORE PLANTING

The long time that the land is occupied by asparagus planting makes it highly desirable that the soil be fertile, free of weeds, and put into the best condition before plants are set. The fertilizer practice depends on local soil and climatic conditions.

Asparagus thrives best in soils well supplied with humus. In mineral soils, the application of some organic material may be more important than the addition of nitrogen, phosphorous, and potassium. Peat and muck soils may need the addition of only one or more of the fertilizing elements to put them in a good state of fertility. Some organic soils need no fertilizer before plants are set.

Organic matter may be supplied in the form of animal manure or, better still, by turning under a green crop. Cowpeas, soybeans, vetch, or clover are preferred because they add some nitrogen to the soil. Smallgrain crops such as rye, wheat, oats, or barley can also be used.

In turning under a green manure crop, attention should be given to its effect on the nitrogen supply in the soil. To keep nitrogen available growers should apply a nitrogen fertilizer to aid in the decomposition process. Leguminous green-manure crops turned under while green and succulent decompose more rapidly than woody material and are less likely to cause nitrogen starvation during decomposition. Green manure should be turned under the season before asparagus crowns are set.

In general, the longer the land has been in cultivation the greater is the need for one or more of the fertilizer elements. Soils in the eastern part of the country are more likely to require high rates of commercial fertilizer than western soils. Specific rates are determined by soil analysis. The fertilizer should be broadcast and thoroughly mixed with the soil. The application of part of the commercial fertilizer may be delayed until after the crowns are set. This part should be applied along the rows and worked into the soil by cultivation.

If a legume is turned under as a green-manure crop, less nitrogen will be required in the commercial fertilizer. Furthermore, soil origin and climatic conditions influence

soil fertility and fertilizer requirements. Because of many such variables, no single fertilizer practice is best under all conditions.

MAINTAINING FERTILITY

Asparagus plantings should be fertilized every year except where trials indicate otherwise. Fertilizer needs and practices vary according to locality, soil type, cultural practices, and the time of season that fertilizers are applied.

Research has shown that potash is the most important fertilizer element for growing asparagus on soils in the Atlantic Coastal Plains areas. An effective formula is to apply 1,600 pounds of 5-10-15 fertilizer. This supplies 80 pounds nitrogen, 160 pounds phosphorus, and 240 pounds potash per acre. Where asparagus is grown on deep, fertile soils, the need to apply fertilizer is diminished.

The time of season when fertilizers are applied is not important in relation to yield. Previously, growers divided fertilizer into a two-part application: The first was applied before growth started in the spring, the remainder at the end of the cutting season. The latter application was made to stimulate top growth and storage of reserve food in the roots. However, this split-application does not produce an increase in yield over the same fertilizer applied either before or after cutting. Also, where 1,600 pounds per acre of a 5-10-15 fertilizer is used prior to the harvest season, there is no need for sidedressing. If potash is applied at a low rate in the spring, yields can be increased

by applying a sidedressing of potash at a rate of 100 pounds per acre in early August. The value of a nitrogen sidedressing during the cutting season is questionable.

Tests in the eastern United States have demonstrated that ridge culture of asparagus increases yield. This yield increase results from production of larger spears. However, the most productive yields can be obtained by using ridge culture in combination with the application of a fertilizer high in potash and an effective herbicide. The recommended rate, as previously stated, is 1,600 pounds per acre of a 5-10-15 fertilizer.

Fertilizer application in the spring can be either the broadcast, over-the-row, or band method. In the broadcast method the fertilizer is applied about 3 inches deep with a grain drill. Over-the-row method consists of applying the fertilizer in 18-inch-wide strips and then working it into the soil by disking. In band placement, the fertilizer is applied about 3 inches deep on each side of the row. Research shows that the over-the-row method is superior in the early stage of a planting and the broadcast method after the eighth cutting season.

Research has also demonstrated that tissue analysis of fern (brush) from plots can be used as a diagnostic aid to determine the correct fertilizer formulation for a particular type soil.

Asparagus needs calcium. It thrives best on soils having a pH of 6.0 to 6.5. Many eastern soils require regular applications of

lime to maintain the calcium content and proper soil reaction. As much as 1,000 to 2,000 pounds of limestone may be required annually for a period of years until the calcium content becomes fairly high. Many eastern soils are also low in magnesium. Where this is the case, apply a dolomitic lime high in magnesium.

VARIETIES

There are only a few varieties of asparagus, and their varietal differences are not well defined. Male and female flowers are borne on different plants. This dioecious condition results in a constant mixing of strains in the field which makes it difficult to obtain seed that will produce plants uniform in type and true to varietal characteristics. Since the crowns are propagated almost wholly from seed, wide variation may appear in any lot of crowns unless special effort is made to isolate the seed-producing plants from the pollen-producers. Where more than one variety is grown for seed, careless handling of seed stocks soon results in mixture and in less distinct varietal differences.

Because of these facts and because the bed or field to be planted will last for many years, care in selecting planting stock is important.

Asparagus varieties are of two general types based on the color of the spears. The more important group includes the varieties Mary Washington, Martha Washington, Reading Giant, Palmetto, and Argenteuil. Spears of this group

become dark green in sunlight. The less important group includes such varieties as Conover's Colossal and Mammoth White. These produce light-green or whitish spears. These light-colored varieties should not be mistaken for white (blanched) asparagus that is grown for canning. The whiteness required for these canned spears is produced by covering the crowns of either the light-green or dark-green varieties with a ridge of soil several inches deep. The blanched spears are cut just as they break through the soil and before they are exposed to sunlight.

The more rust-resistant Mary Washington and Martha Washington varieties have replaced the older light-green varieties and the dark-green variety, Palmetto. Reading Giant and Argenteuil have also largely been replaced by the Washington varieties.

Besides rust resistance, the Washington varieties have high commercial quality. They are fully equal or superior to other leading varieties on the market in earliness, vigor of growth, and size and quality of shoot. They are also more uniform in size, shape, and color than the old standard varieties; and they produce large spears.

Since 1940, several selections of Washington-type asparagus have been introduced. These selections are reported to be partially resistant to rust, but none is immune to rust when conditions favor rust development. Of these, California 500, developed in that State, is the most extensively grown in the West. Seneca Washington and

Waltham Washington were developed in the East. New Jersey Approved was developed in that State by the selection of early, vigorous plants which were moved to an isolated area for seed production. Only first generation seed from the selected plants is recommended.

In establishing a new planting it is important to use one of the rust-resistant varieties, especially in localities subject to rust epidemics. In fact, many nurserymen and plant growers now list only the varieties resistant to asparagus rust. More information on rust is given in this bulletin in the section on asparagus diseases.

GROWING AND HANDLING CROWNS

Where a large acreage of asparagus is to be planted, a grower should raise his own plants. The advantages far outweigh the disadvantages: (1) The grower can select his own source of seed; (2) it usually costs less to grow large quantities of crowns than to buy them; (3) special care can be exercised to produce large healthy crowns; (4) selection can be practiced and only the best crowns transplanted; (5) the crowns can be transplanted soon after digging with less injury from exposure and drying.

The first essential in growing crowns is to buy good seed of the desired variety. The crossing that occurs in the field, as already mentioned, adds greatly to the difficulty of obtaining seed of known quality. Unless special care

is exercised in the selection and handling of both the seed-bearing and the pollen-bearing plants, the seedlings may be somewhat variable.

Seed capable of producing high-yielding crowns can be obtained only by the selection of high-yielding parents. High-yielding male and female plants should be selected and isolated in such a way that the selected female plants receive pollen only from the selected males. Seed obtained from parents selected and protected in this way will produce crowns capable of a much higher average yield than seed from unprotected field-grown parents. But even a small difference in yield per crown resulting from careful selection of seed stock may mean great difference in profit over the lifetime of the planting.

Close attention must be given the seedbed if good results are to be obtained. Land virgin to asparagus should be used for the seedbed to avoid *Fusarium* root-rot (see "Diseases", page 19). The soil should be worked until it is free of clods; germination is likely to be poor in a rough, cloddy soil. A finely pulverized, well-prepared seedbed permits the seed to come into closer contact with soil particles, thereby hastening and improving germination.

Asparagus seed is slow to germinate; plants appear above ground in 4 to 6 weeks, depending on soil temperature, moisture, and depth of covering. Asparagus seed absorbs water slowly at temperatures below 70° F; and if dry seed

is planted in cold soil, several weeks may be required for the seedlings to appear. Germination of asparagus seed can be hastened by soaking the seed in water. Seed so treated, however, must be handled properly or more loss than gain may result. Seed should be soaked at a temperature of 85° to 90° F. for 4 or 5 days. After soaking, the seed must be dried and planted at once. Otherwise, decay organisms may develop and damage the seed. For best results, soaked seed should be planted in moist soil.

Asparagus seed should be planted early in the spring, as soon as the soil becomes warm enough for germination. The best soil temperature for germination is between 75° and 85° F. Below 70° germination is very slow.

Early planting lengthens the growing season and makes it possible for larger crowns to develop. In the Imperial Valley of California, asparagus seed is often planted late in January or early February; in the North, frequently in late May; and in New Jersey, in early April.

If germination is known to be good, seed should be planted thinly. It is better to allow enough space for plants at seeding time than to attempt to thin them later. Thinning is difficult, and if the crowns are grown so close together that the roots are interwoven, they are hard to separate after digging. Moreover, thin seeding saves time and reduces root injury in separating the crowns. The best spacing can be obtained by planting with a mechanical

seeder, which can be adjusted to drop a single seed at regular intervals.

In growing asparagus crowns for field planting, seed should be planted in rows 24 to 30 inches apart and 10 to 12 seeds per foot of row. At this rate, 1 to 2 pounds of seed will grow enough crowns to plant an acre.

Depth of planting depends upon the type of soil and the moisture conditions. The heavier the soil, the shallower the seed should be covered. Seed is covered primarily to provide proper moisture for germination. In light peat the seed may have a 3-inch cover; in sandy loam 1½ inches is enough, provided the soil is sufficiently moist for germination.

Weeds should be controlled by cultivation, by use of herbicides, or by a combination of the two. Cultivation should be shallow, especially late in the season, to prevent injury to the developing roots.

Before the crowns are dug, the old tops should be cut and removed so they will not interfere with the digging. A potato digger is best for lifting asparagus crowns. U-shaped blades may cut the roots too short, and a plow makes too much work in separating crowns from the soil. In digging the crowns care should be exercised to avoid injuring the roots. If the plants are lifted without injuring the tips of the fleshy roots, the roots will continue to elongate after being transplanted. Since the fleshy roots are essentially storage organs, it is important

that their development be checked as little as possible.

Crowns should be set as soon as possible after they are dug. If it is necessary to keep the crowns for a period before setting them out, they should be stored in a dry, protected place at a temperature near 40° F. Crowns should not be stored in pits; they may be injured by heating. And they should not be allowed to dry out excessively.

Experiments conducted in California showed that yields from dried crowns were much less than those from crowns not permitted to dry out. Although greatest reduction occurred during the first cutting season, the injurious effect of drying the roots was still apparent in the second season.

STARTING THE PLANTING

Local climatic conditions must be considered in determining the best time to plant crowns. In most sections of the country asparagus crowns are set as early in the spring as the soil can be worked. In some parts of the South and in the Delta and Imperial Valley districts of California, where climatic conditions are favorable, the roots are set late in the fall or during the winter. Fall and winter planting is necessary in some districts because heavy rains may interfere with spring planting. Spring planting is preferred in the North because fall-planted roots may be injured by cold before they become established.

Age, Size, and Sex of Crowns

One-year-old crowns are the most desirable for setting. Under

some conditions the grower may be justified in planting small, 2-year old crowns, but crowns more than 2 years old should never be used. Divisions of old crowns are entirely unsuited for setting a new bed. Two-year-old crowns should not be used unless there is sufficient space in the nursery row for proper development. More productive plantings can be obtained by using 1-year-old roots. Where the crowns are grown very close together, the fleshy roots may be injured in separating the crowns. Severe root injury materially reduces the yield in following years.

It is profitable to grade asparagus crowns on the basis of size and vigor, and to keep only the largest and best developed roots for planting. All small, weak crowns and those having many small buds should be discarded. They tend to produce a high percentage of unsaleable spears. A desirable root for planting has a large, well-developed root system with large buds well distributed over the crown.

Female plants produce larger spears than male plants, but male plants produce a larger number of spears with a greater total weight. The difference is so small, however, that it seems advisable for the grower to pay particular attention to the selection of large, vigorous 1-year-old roots and leave the matter of sex to chance. Sex cannot be determined in most plants until the second year of growth.

Soil Preparation

The soil in which asparagus crowns are to be set should be plowed deep and worked down by thorough disking. Furrows for the crowns can be opened with a double moldboard plow or some other suitable implement (fig. 1). The depth of the furrow will depend on the soil type. A deeper furrow is required in loose soil than in heavy soil because the crowns are set 6 to 12 inches deep in loose soil and only 3 or 4 inches deep in heavy soil.

Planting Distances

Planting distances are best determined by the grower. The distances depend on whether white (blanched) or green asparagus is to be grown, the type of cultivation to be practiced, the section of the country, soil conditions, and the size of the planting.

Green asparagus does not



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Figure 1.—This implement is a type used to open furrows for setting asparagus crowns. The blade can be adjusted to make furrows of the proper depth.

require as much space between rows as white asparagus. Asparagus that is blanched by keeping soil ridged over the crowns should be spaced about 7 to 8 feet between rows to provide enough soil to form the ridge. For growing green asparagus the distance between rows is preferably 4 to 5 feet. If green asparagus is to be marketed early in the season and blanched asparagus from the same bed is to be marketed later in the season, the rows should be spaced for growing the blanched product.

Spacing between plants for green asparagus must be adjusted to local conditions. Twelve-inch spacing in rows 4 to 5 feet apart is suitable for the east coast and the Midwest. In California, 12 inches between plants is preferred in rows 5 feet apart for green and 8 feet apart for white asparagus.

A large percentage of small spears will be produced if crowns are set too close together. Too much space between plants reduces yields even though the spears are larger.

Setting the Crowns

Deep planting of crowns, formerly a general practice, is no longer recommended. In loose, light, organic soil, such as muck, crowns should be planted deeper than in the heavier mineral soils. Most commercial plantings in light soils are made at a depth of about 8 inches. In mineral soils it is doubtful whether it is a good practice to set deeper than 4 inches. Experiments in Massachu-

setts in mineral soil showed that the loss of plants after setting increased from 11 percent at 4 inches to 34 percent at 8 inches.

Wild asparagus plants are known to do well with no more covering over the crown than that which resulted from the natural covering of the seed. This indicates that home-garden asparagus probably can be obtained from crowns which grow from seed and are not even transplanted. Where deep planting is practiced it is best to cover the crowns to a depth of only 2 or 3 inches at planting time and to increase the covering by filling in the planting furrows gradually as the shoots develop.

Although careful spreading of the roots is a good practice and should be done in small plantings, generally no attempt is made to spread the roots in large plantings, as it requires considerable time and labor.

CULTIVATION AND CARE

Cultivation should begin soon after the crowns are planted and should continue throughout the season at intervals frequent enough to keep down weeds. Any stirring of the soil should be shallow, since serious injury to the roots may result from deep cultivation. This is especially true after the root system has become extensive and the crowns have grown near the surface. Tractor-mounted cultivators are used on large plantings and are satisfactory if properly adjusted. When crowns are

planted in deep furrows it is a good practice to fill soil into the furrows at intervals. This filling also gives weed control in the rows during the year the crowns are planted. After the first season some hand hoeing is necessary to keep down weeds near the plants. Any working of the soil close to the crowns during the cutting season must be shallow and carefully done to avoid injuring the developing spears.

If white, or blanched, asparagus is grown, the rows must be ridged to cover the crowns with several inches of soil. The soil over the crowns must be deep enough for the spears to attain the desired cutting length before reaching the surface. To keep the crowns properly covered it may be necessary to renew the ridges at least every 2 weeks.

If green asparagus is grown, a very low ridge is suitable. The crown of the asparagus plant increases in thickness and thus comes a little nearer the surface each year, so that slight ridging may be necessary when the crowns have come very close to the surface. Too shallow covering of the crowns subjects them to excessive heat during hot weather. This heat causes the tips of the spears to open before the spears reach the desired length and reduces their market value.

At the end of the cutting season, the asparagus beds should be thoroughly cultivated, the ridges leveled, and the planting given flat culture for the remainder of the season. The ridges can be leveled with a disk harrow. On

large plantings the work of leveling the ridges, like many other field operations, is done with implements especially designed for the job.

Growers do not agree on the best method of handling the stalks (bush) that grow up after the cutting season. In parts of the North, they let the stalks stand overwinter so that they will hold the snow and prevent soil blowing. Stalks are then disked into the soil in the spring. Some growers cut off and either remove or burn the stalks as soon as the berries begin to mature. This prevents the scattering of seed. However, the stalks must not be cut off before they have manufactured and transferred to the fleshy roots enough reserve food to assure a vigorous growth of spears the following year. For this reason it is desirable to let the stalks stand until they are dead. Burning brush robs the soil of much needed organic matter. Mature, dormant stalks are easy to incorporate into the soil everywhere except in the Imperial Valley of California. There they may have to be shredded before plowing them under.

Intercropping is often practiced by growers who want income from their asparagus beds the first year or two after the crowns are set. This practice is not recommended, however, and most successful growers do not intercrop.

WHEN AND HOW LONG TO HARVEST

The age at which asparagus plants are ready for harvest and

the length of the cutting season differ in various sections of the country. Where the growing season is long and relatively cool—in California, for example—spears may be harvested at an earlier age.

In areas having a long, cool season, growers can cut asparagus for 2 to 3 weeks after crowns have been set for a full year—without injuring plants. The cutting period in the second harvest year may be extended to 6 to 8 weeks in these sections, and up to 12 weeks in following years.

Where growing seasons are short and warm, spears normally should not be harvested until after the crowns have had 2 full years of growth. Cutting should then be limited to a period of 3 to 5 weeks. The cutting period for the fourth and following years is usually 6 to 8 weeks.

When asparagus beds decline in production and yield a large proportion of small spears prematurely, the trouble can often be traced back to overcutting during the previous seasons. When such a condition develops it may be beneficial to shorten the cutting season and give particular attention to fertilization and care while the plants make top growth. As the beds grow older, however, the proportion of small spears increases, even in well cared for beds.

PROFITABLE PRODUCTIVE PERIOD

The establishment of a new asparagus planting involves much labor and expense. Adding a few

years to the productive life of the bed therefore may be of considerable economic importance. If properly cared for, a planting normally will produce profitable yields for 10 to 15 years. On very fertile soil and with special care, a bed may remain profitable for 20 or more years.

Asparagus yields can be expected to increase for several years following the setting of the crowns. After reaching the peak, profitable yields may continue under favorable conditions up to 12 to 15 years. Then the yield is likely to decline. It is generally desirable to renew the planting after 10 to 12 years. The new bed should be started 2 or 3 years in advance of plowing up the old one, so that it will be yielding profitably before the old bed is abandoned. It may be advisable to renew portions of large plantings each year until the entire acreage has been replaced. Old asparagus beds should not be used for new plantings because of the build-up of the *Fusarium* wilt pathogen.

Climatic conditions, soil texture, soil fertility, planting distances, diseases, insects, and cultural and harvesting methods determine the number of years an asparagus bed will remain productive. Although very light soils are ideal for maximum production for several years, beds in light soils are likely to be shorter lived than those in heavier soils.

Continued high production requires that the beds be kept free from diseases and insects. By interfering with top growth after the cutting season, diseases and

insects reduce the amount of reserve materials stored in the fleshy roots and rhizome. Any reduction of the normal reserve food supply will reduce the succeeding crop.

Improper cultural practices may interfere with crown development and shorten the life of the bed.

HARVESTING THE CROP

Three classes of asparagus, based on the color of spears, are marketed. Spears may be entirely green, green with white butts, or entirely white. Green asparagus is in greatest demand for the fresh market, but canning asparagus may be either green or white. Nearly all the green asparagus is harvested with a little white on the butt end. Entirely green spears are cut at the surface and do not keep as well as those cut below the surface. Since the underground part of the stem is more woody than that above ground, it loses moisture less rapidly than the tender green part and adds to the keeping quality of the spear.

Asparagus shoots grow very rapidly and require frequent cutting, especially if the temperature is high. Early in the season the shoots may require cutting only every third day. But as the growth becomes more active, spears may have to be cut twice a day. This is particularly true if the asparagus is growing on very light, warm soil.

Green asparagus spears should be cut 9 to 10 inches long, and at least half of the length should be above ground. The underground

part is fibrous and unpalatable. When cutting, always use an asparagus knife, and take care to avoid injury to the young spears developing underground. The spears should not be cut closer than 2 inches from the crown to avoid injury to the developed buds on the rhizome. Knife injury to buds and immature shoots causes them to develop into crooked spears (fig. 2).

Marketable spears can be cut without injuring the developing shoots. Place the knife near the shoot to be cut, force it straight down to the desired depth, then tilt it to make the cut. Many young shoots may be damaged if the knife is forced into the ground at an angle. (See cover illustra-



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Figure 2.—The deformed spear on the left is a typical result of cutting-knife injury to young shoots. Growth is slowed down on the injured side of the young shoot, and the spear develops with a pronounced crook. Shoots damaged by cutworms are deformed in the same way.

tion.) Asparagus shoots should not be cut above ground so that stubs remain. Stubs interfere with harvesting and may injure the hand of the cutter. Spears should be removed from the field as soon as possible after cutting (fig. 3).

The scarcity and increasing cost of hand labor has caused many growers to mechanize their operations. Some growers have used machines successfully for cutting asparagus. Mechanization is expected to increase as machines are improved.

PREPARATION FOR MARKET

Asparagus loses its edible quality very rapidly after it is harvested. Sugar content declines and the amount of fibrous material increases. These changes take place most rapidly during the first 24 hours after harvesting. This is particularly true in white asparagus.

Deterioration goes on at all

temperatures, but it is much slower near 32° F. Because of the rapid loss in quality at high temperatures, asparagus must be moved from the field, bunched, packed, and placed in a cool atmosphere as soon as possible after it is cut. Spears should be protected from the sun as much as possible if they are harvested during very warm weather.

Asparagus is generally prepared for market by grading, trimming, and tying the stalks in bunches weighing 2 to 2½ pounds. Because certain eastern markets prefer a small bunch, some asparagus is either packed in 1-pound bunches by the producer—or the large bunches are divided into smaller ones by the retailer. Field-run and low-grade asparagus is sometimes packed in crates without grading or bunching. In some localities even first-grade asparagus is shipped loose in crates. However, care in grading, bunching, tying, and wrapping should add consider-



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Figure 3.—This crew is cutting and placing spears directly in boxes in one pass through the field. Spears are removed from the field only a few minutes after being cut.

ably to the selling price of an asparagus crop.

Storing the Crop

Usually, fresh asparagus is stored temporarily only when the market is overstocked. It can be kept successfully for about 3 weeks at 36° F. and 95 percent relative humidity. After 5 to 7 days in transit, the safe storage period will decrease. If the storage period is to be 10 days or less, spears can be stored at 32°; if held longer at this temperature, asparagus is subject to chilling injury. At high temperatures (particularly above 40°), the spears will grow, develop decay, and lose their vitamin content, tenderness, and flavor. To avoid this deterioration, asparagus should be cooled

immediately after cutting. This is ordinarily done by hydrocooling.

During transit and storage, the butts of asparagus are placed on wet moss (fig. 4) or other moist, absorbent material to prevent loss of moisture and maintain freshness of the spears. In storage, asparagus bunches are sometimes set in water in shallow trays or pans.

Bacterial soft rot is the principal cause of decay in storage. It may occur at either the tip or butt of the asparagus.

Grading the Spears

The U.S. Department of Agriculture has established market grades (fig. 5) for asparagus. Information on the latest grades may be obtained by writing to the



BN-21071

Figure 4.—Bunches of asparagus are placed on damp moss in a flat to keep them fresh.



BN-25321

Figure 5.—An inspector selects a representative sample from a shipment of asparagus and inspects it to determine the grade. Grading procedures vary in different parts of the country and for different markets.

Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D.C. 20250.

Asparagus is marketed chiefly under two grades, U.S. No. 1 and U.S. No. 2. Asparagus not meeting the specifications required by these grades is considered as unclassified. Asparagus is graded primarily for freshness, length and diameter of the spear, proportion of the spear that is green, and the amount of damage due to dirt, diseases, and insect or mechanical injury.

Current specifications classify asparagus on diameter of spears as follows: Very small, less than $5/16$ inch; small, between $5/16$ and $8/16$ inch; medium, between $8/16$ and $11/16$ inch; large, between $11/16$ and $14/16$ inch; and very large, above $14/16$ inch. Present standards permit the trimmed

bunches to vary in length from 7 to $10\frac{1}{2}$ inches.

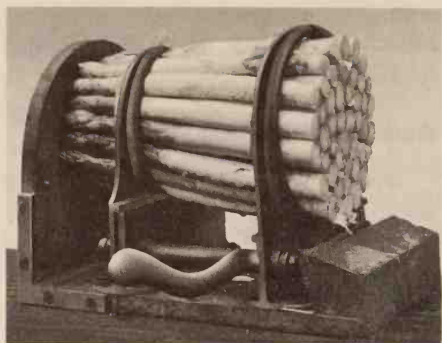
Washing, Bunching, and Tying

White asparagus is usually washed. Spears are placed in wire-bottomed trays or baskets and doused a few times in a vat of water. Green asparagus should not be washed, unless a considerable amount of soil adheres to the spears. If it is necessary to remove soil from the butt end of green asparagus, the butts only should be doused in a vat of water. Care should be taken not to wet the tips. The stalks should then be laid with the butt downward on a sloping surface to drain before they are bunched. Asparagus keeps best if it is not wet.

Where asparagus is grown in large quantities for commercial purposes, it is essential to have a mechanical buncher for holding the stalks while they are being bunched and tied. There are various devices on the market for this purpose (fig. 6).

Many growers have machinery that cuts the spears to the desired length, but some of the trimming is done by hand. A large number of spears can be trimmed at one operation by placing them in a frame that holds all the tips even. The extra length of stem is then cut off with a large knife. Where a small bunching machine is used the spears are usually cut to the desired length while held in the buncher.

The tightest and most attractive bunches are made by tying near each end (fig. 4). A single tie near the center permits slipping



BN-27651

Figure 6.—One type of asparagus-bunching device. Note that the spears have been cut to a uniform length.

and makes an unattractive bunch. Raffia, twine, and tying tape are the materials most commonly used for tying the bunches. Tying tape is the most expensive, but it is recommended. Raffia does not have the neat appearance of tape, and twine is likely to cut the spears if tied very tight. Tape is available in various colors, and sometimes grades of asparagus are indicated by the color of tape. Only good grades of tape having fast colors should be used. Any discoloring of the spears from dye may lower the market value.

There is some shrinkage in asparagus after it is bunched, especially if it has a high water content before bunching. Bunches should be tied as tight as possible without injuring the spears to avoid loosening as a result of shrinkage.

Many growers and shippers market an attractive product by wrapping bunches in parchment paper so that only the tips of the spears extend above the paper. The wrapper usually bears the name

and address of the grower or shipper. This is a good way to advertise a high-quality product.

Packing and Shipping

Shipping crates differ from one growing area to another. The most commonly used crate is pyramidal in form (fig. 7), having two compartments each holding six 2- to 2½-pound bunches. A typical pyramidal crate used in California is 11 inches deep, 9 inches wide at the top, 11 inches wide at the bottom, and 18 inches long. A similar crate is used in Georgia and the Carolinas. The tendency in most States is toward this type of crate, but the dimensions may vary. The pyramidal crate makes an excellent shipping container because the shape conforms to the taper of the bunches and prevents them from shifting about during shipment. The bottoms of the crates are usually lined with a type of paper that holds water or with a layer of damp moss. The butts of the bunches are placed in the water or on the moss. When packed in this way and kept at a temperature just above freezing, asparagus can be shipped a long distance and will keep for several days without serious loss of quality.

In the early part of the cutting season when the yield is small and the product is sold in nearby markets, asparagus is shipped without refrigeration, either by express or by motortrucks. However, after the cutting becomes heavy and carlot shipments begin, most of the asparagus is shipped under refrigeration.



BN-27650

Figure 7.—Asparagus packed in pyramidal crates.

WEEDS

The control of weeds is one of the most costly practices in the production of asparagus. Several herbicides have proved very efficient and economical in controlling weeds in this crop.

Winter annual weeds can be effectively controlled with 1.3 pounds of dinoseb per acre. It is applied in 10 to 40 gallons of water after the asparagus is dormant in the fall but prior to weed emergence. Established broadleaf winter weeds can be killed in the early stages of growth with the same treatment.

Perennial grasses in asparagus fields can be controlled with dalapon (2,2-dichloropropionic acid). It has proved effective as a directed spot spray for control of small areas of perennial grasses such as quack-grass, Bermuda grass, and Johnson grass.

INSECT PESTS

Asparagus beetles

Asparagus beetles cause more widespread damage to asparagus in this country than any other insect. There are two species—the asparagus beetle (*Crioceris asparagi* (L.)) and the spotted asparagus beetle (*Crioceris duodecimpunctata* (L.)).

The adult of the asparagus beetle is about $\frac{1}{4}$ inch long, metallic blue to black with orange to yellow markings. It overwinters in the adult stage in protected places—old asparagus stalks, under debris along fence rows, or in nearby woodlands. Emergence occurs early in the spring about the time asparagus shoots appear. The young tips are damaged by beetle feeding and egg laying. The eggs are normally dark in color and attached singly on end. Feed-

ing injury or the presence of eggs seriously reduces the market value of asparagus.

Eggs are also laid on the mature plants later in the season. They hatch in about 1 week, depending upon the temperature, into soft-bodied larvae or grubs about 1/3 inch long when full grown. The larvae are olive green to dark gray with black head and legs. After about 10 days to 2 weeks, the larvae drop from the plants and enter the ground where they pupate. In another week or two the new adults emerge from the soil. Two or more generations may develop during the season, depending upon weather conditions.

Heavy populations of larvae and adults will soon defoliate large areas. Because the asparagus beetle does not thrive during hot dry weather, it does most of its damage in the spring and early summer.

The adults of the spotted asparagus beetle are reddish orange, and they each have 12 black spots on their backs. These beetles normally appear a little later in the spring than the adults of the asparagus beetle. The eggs are slightly smaller than those of the other species. They usually do not appear until late in the season when the berries are starting to form on the asparagus plants. The larvae are orange. They feed primarily inside the berries. The life history is similar in many respects to that of the asparagus beetle.

Control measures for both asparagus beetle and the spotted asparagus beetle are the same.

During the cutting season, apply 1-percent rotenone dust at 30 pounds per acre—or rotenone spray containing 3 pounds of 5-percent rotenone powder per acre. In preparing the rotenone spray, mix the powder with a small amount of water until a thin even paste is obtained. Add this mixture to the water in the spray tank with the agitator going. Malathion dust or spray at 1¼ pounds, or carbaryl dust or spray at 2 pounds of active ingredient per acre, may also be used.

For control of asparagus beetles after the cutting season or on plantings not being harvested, use carbaryl dust or spray at 2 pounds of active ingredient per acre.

All applications should be thorough and uniform. Repeat about every week or 10 days. Note: Carbaryl cannot be repeated within 3 days.

Cutworms

Cutworms of more than one species occasionally cause damage to asparagus by cutting off the shoots underground or by feeding on the tips of the spears as they appear above ground. Damaged tips may develop into crooked spears (fig. 2). Cutworm larvae may be dull gray, brown, or black, and either striped or spotted. They are stout, soft bodied and smooth, and they grow to 1¼ inches long. They curl up tightly when disturbed.

Carbaryl applied for control of asparagus beetles provides adequate control of cutworms. If treatment for cutworms is necessary and asparagus beetles are not

a problem, cutworm control can be obtained with an application of 5 percent carbaryl bait at 2 pounds active ingredient per acre.

Thrips

Thrips sometimes are pests of asparagus. They are small active insects that can easily go unobserved unless a close examination is made. Their size makes it possible for them to hide in the head of the tip or under the bracts on the stem. Their presence in large numbers on asparagus at the time of harvest may render the tips unacceptable for market.

Control thrips on asparagus by applying malathion dust or spray at 1½ pounds of active ingredient per acre.

Garden Symphylan

The garden symphylan (*Scutigera immaculata* (Newp.)), also known as the garden centipede, is destructive to asparagus. It is neither a centipede nor an insect. It is a slender, white creature up to 3/8 inch long having 12 pairs of legs when full grown. The young is smaller and has fewer legs. It eats numerous tiny holes in the underground portions of the plants.

Flooding is recommended in California for control of this pest. In summer before planting, fields should be flooded using a minimum of levee area. It is essential that the soil be completely covered for a 2-week period.

Where infestations have developed in established fields, efforts to control the symphylans

with side dressings or drenches have met with limited success. Unless so stated on the label, application of pesticides as a side dressing or a drench for symphylan control are not recommended.

DISEASES

Asparagus Rust

Asparagus is subject to a number of diseases. Asparagus rust, caused by the fungus *Puccinia asparagi*, is one of great economic importance. Rust was first reported in 1896 in New Jersey, Delaware, Long Island, N.Y., and New England. It later appeared in practically all areas where asparagus is grown. The presence of the disease depends on environmental conditions. Rust spores require moisture for germination; the disease is much more destructive in areas of high humidity and heavy rainfall than in low moisture areas.

Asparagus rust normally is seen first as numerous small reddish-yellow spots on the main stems near the ground and on the very slender branches of the stalks that grow up after the cutting season. The red spots are pustules containing seed-like bodies, or spores, that reproduce the fungus. These pustules burst and release large numbers of rust spores. These spores have the appearance of reddish or rust-colored powder. The wind scatters the spores rapidly; and if sufficient moisture is present, they may infect all the plants in the field.

Asparagus rust causes the tiny needlelike branches of the stems to fall and the affected plants present a naked appearance (fig. 8, A). When the attack is severe, the entire field may ultimately become brown and appear dead (fig. 9). The effect of rust is not directly evident on the marketed product because damage to top growth occurs primarily after the harvest season. Injury to the brush slows the manufacture of food, and the plants are either killed or go into the winter in a starved condition. As a result, the succeeding crop suffers a reduction in

the size and number of shoots produced.

The most effective way to control asparagus rust is to plant resistant varieties. When first introduced by the U.S. Department of Agriculture, Martha Washington and Mary Washington varieties generally showed a high resistance to rust. In recent years, however, losses have occurred from rust on varieties reported to be either Mary or Martha Washington. Either high rust resistance has not been maintained in some stocks of these varieties or there are strains of the rust fungus to which they are not highly resistant. When buying any variety of the Washington type, growers should obtain information regarding the previous performance of the stock with respect to rust resistance.

Because rust has been reported on even the resistant varieties, growers should take measures to protect all plantings by eliminating sources of rust infection. The two main sources of infection are wild asparagus plants growing in the vicinity of cultivated beds and seedlings that are allowed to grow up in the field before the cutting season is over.

Wild asparagus carries the rust overwinter, and in the spring spores scatter and infect the plants. Seedlings that are allowed to grow up in the field during the cutting season also provide the disease organisms an opportunity to develop and multiply into great numbers of spores. Sources of infection can be eliminated by digging and burning all wild



BN-25320

Figure 8.—A, Seedlings of Argenteuil asparagus, showing some resistance to rust; B, the highly rust-resistant Washington asparagus.



BN-25322

Figure 9.—An old asparagus field killed out by rust (foreground). The new field of the Reading Giant variety on the left was grown as a breeding field for rust-resistance work.

plants, and by preventing the top growth of shoots in the field until after the cutting season.

New beds should be planted with rust-resistant strains and located as far as possible from the old beds. The new plantings can be further protected if they are located so that prevailing winds will not blow from the direction of established plantings. In the fall the top growth should be removed from the 1-year-old beds that are to be cut the next year.

The removal of the top growth from mature beds in the fall is not necessary in rust control. The spring stage of rust will not occur in fields where the tops are left overwinter and disked into the soil in the spring. It will occur, however, if tops are allowed to start growing before the cutting season is over.

Spraying with fungicides to control rust has met with varied success in different locations. Zineb can be used at the rate of 1.5 to 2.25 pounds of active ingredient per 100 gallons of water.

Apply immediately after last harvest; repeat at 10-day intervals as long as necessary. In young fields not to be harvested, start when disease first appears in the area. Maneb may also be used to control rust on asparagus.

Fusarium Root Rot

Fusarium root rot, caused by the fungus, *Fusarium oxysporum f. asparagi*, is common in all areas where asparagus is grown in the United States. It generally attacks the feeder rootlets and weakens and kills many plants, thus reducing stand and yield. Rarely does it produce wilt symptoms, except on young shoots of seedlings.

Fusarium fungus builds up in the soil when the first bed is planted in the field, and the disease persists for many years. It is especially troublesome for seedbeds planted on the same soil in subsequent years.

Yields on replanted land are reduced more by Fusarium root rot year after year than by rust,

because rust may occur one year and not the next.

Asparagus shoots infected with *Fusarium* root rot may show a brown discoloration of their surface. These spears are usually unfit for market.

The best control for *Fusarium* root rot is to avoid using old asparagus soil.

PRECAUTIONS

Pesticides used improperly can be injurious to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Some States have special restrictions on the use of certain pesticides. Before applying pesticides, check State and local regulations.

Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them. Promptly dispose of empty pesticide containers; do not use for any other purpose.

When handling a pesticide, wear clean, dry clothing.

Avoid repeated or prolonged contact of pesticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of pesticide dusts or mists.

Avoid spilling a pesticide concentrate on your skin, and keep it out of your eyes, nose, and mouth. If you get a concentrate on your skin, wash it off

immediately with soap and water. If you spill a concentrate on your clothing, remove the clothing immediately and wash the skin thoroughly. Launder the clothing before wearing it again.

Carbaryl, malathion, and rotenone can be used safely without special protective clothing or devices if they are in diluted dust or waterspray forms.

Do not apply rotenone, malathion, or carbaryl within 1 day before harvest. Do not repeat carbaryl applications within 3 days.

After handling a pesticide, do not eat, drink, or smoke until you have washed your hands and face. Wash any exposed skin immediately after applying a pesticide.

Avoid drift of pesticide to nearby wildlife habitats, bee yards, crops, or livestock. Do not apply pesticide under conditions favoring drift from the area to be treated.

Many pesticides are highly toxic to fish and aquatic animals. Keep pesticides out of all water sources such as ponds, streams, and wells. Do not clean spraying equipment or dump excess spray material near such water.

Do not apply pesticides to plants during hours when honey bees and other pollinating insects are visiting them.

Have empty pesticide containers buried at a sanitary landfill dump, or crush and bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies.

It is difficult to remove all traces of herbicides from equipment. For this reason, do not use the same equipment for applying herbicides that you use for insecticides and fungicides.



Use Pesticides Safely
FOLLOW THE LABEL
U.S. DEPARTMENT OF AGRICULTURE